Portagauge And Satellite Sea level monitoring system for the Southwest Indian Ocean

PASS-SWIO

ESA Contract 4000136883/21/I-DT-Ir

User Requirements Survey - Summary of Results

Issue	Date	Comments
1.0	13/12/2022	

Table of Contents

1 Introduction

This document summarises the responses to a PASS-SWIO user requirements questionnaire. The questionnaire was designed to acquire input from users which will help the project team understand requirements for sea level information in Madagascar and identify gaps in current availability. This will contribute to work packages (WPs) 1000 (User Engagement and Capacity Building) and 4000 (Implementation Road Map). In WP 1000 it will ensure that any capacity development will meet key requirements and complement existing capability. In WP4000 it will go towards ensuring that plans for future portagauge deployments meet priority needs.

We understand that this questionnaire can only provide an initial overview of the range of users and uses of sea level data as represented by the respondents, and that answers may not be representative of all users. We plan to follow up the questionnaire with meetings with key stakeholders during a visit to Madagascar in 2023 where we will review these findings in greater detail and arrive at more specific recommendations.

2 PASS-SWIO User Requirements Questionnaire

A questionnaire was developed and issued in English and in French on the Jisc online surveys platform (jisc.ac.uk).

The questionnaire comprised 25 questions in 5 sections:

1. About you (Information about the responder)
2. Data tools and services
3. Sea level data requirements and applications
4. Priorities, risks and challenges
5. Capacity building and training

GDPR requirements were adhered to, and personal information only retained if the respondent agreed.

The questionnaire was issued following the online workshop held on 14th September, and closed on 1st November.

A full copy of the questionnaire in English is included in the appendix.

3 Questionnaire Responses

We had a total of 17 responses to the questionnaire, with 16 people completing the French version, and one the English version. All respondents are based in Madagascar.

3.1 **Respondents – “About You”**

3.1.1 Gender and Age

Questionnaire respondents were 41% female, 59% male, Figure 1.

The majority of respondents were over 35, with one respondent was in the range 25 to 35, and one preferred not to state their age (Figure 2).

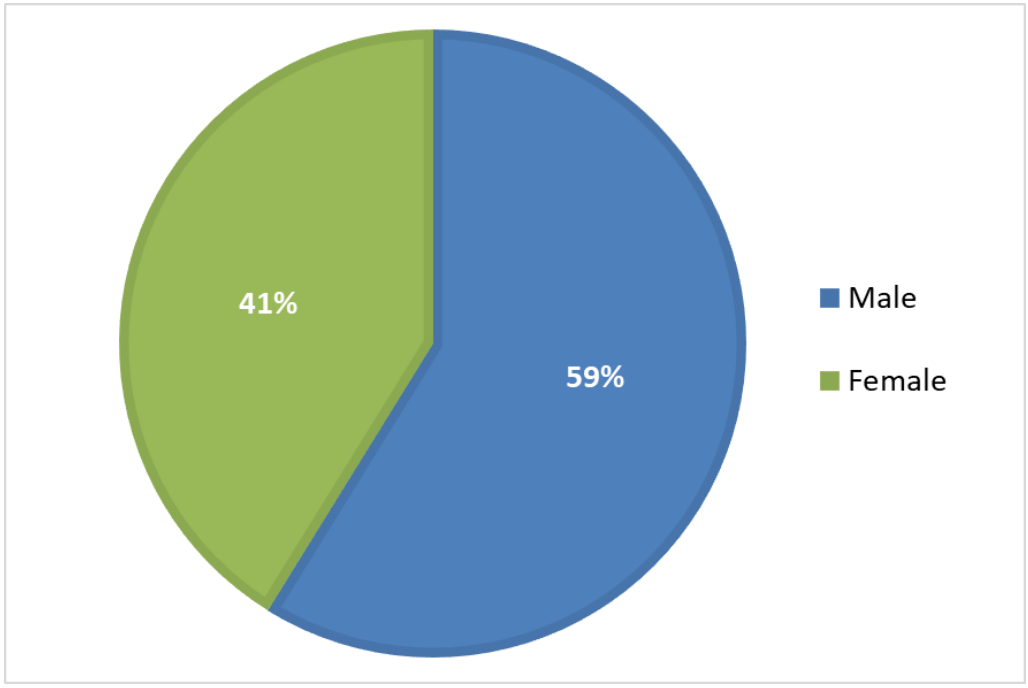

Figure 1. Gender of questionnaire respondents

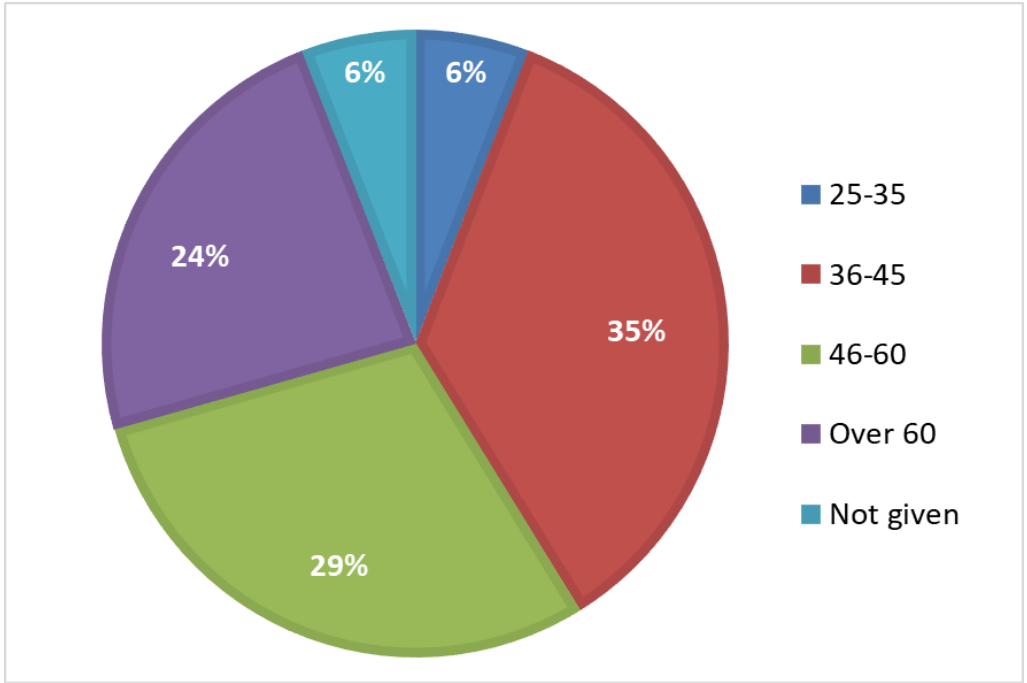

Figure 2. Age of questionnaire respondents

3.1.2 Employment, Skills and Areas of Interest

Of the respondents, 10 are employed by the government in a range of ministries (Office for the Environment, Fisheries and Blue Economy, Planning and land services, Higher education, Ministry

of Transport and Meteorology), three worked for Non-Governmental Organisations, three for Research Organisations, and one for an operational agency (Maritime Information Fusion Centre).

Respondents were able to select multiple areas of employment and expertise, the total number of people identifying with each topic are listed below (number of responses in parentheses):

- Coastal Zone Management (7)
- Government (5)
- Cartography / Mapping (5)
- Fisheries (5)
- Conservation (4)
- Planning (4)
- Oceanography (3)
- Meteorology (3)
- Operations Management (1)
- Forest Ecology (1)
- Emergency Response (1)

From these answers, we see the respondents cover a wide range of areas of interests, which may have different requirements in the way that sea level data are processed and used.

In terms of skills and experience, four respondents had PhD's, five had Master's degrees, two were engineers, two had diplomas, and two were students working towards doctorates. 70% of respondents had over ten years' experience and half of those had worked in this field for more than 20 years (Figure 3).

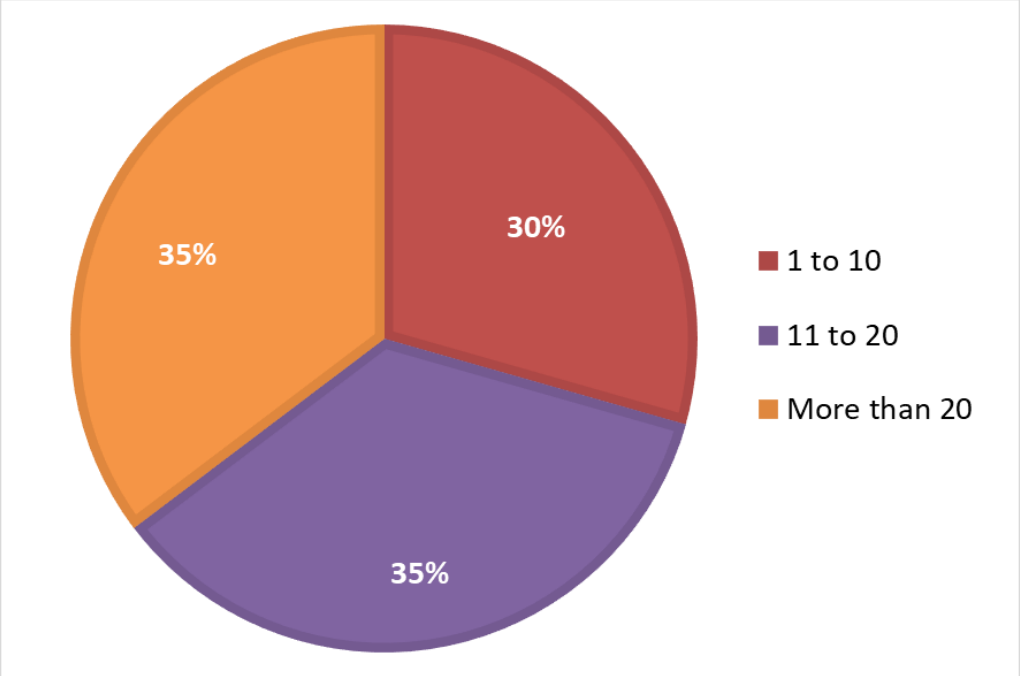

Figure 3. No. of years' experience in the field

Finally, the job titles of respondents indicated a generally high level of responsibility, with 12 at director, manager or head of service level; one GIS specialist; one collaborator; and three researchers / research assistants.

3.2 Data, Tools and Services

The questions in this section were intended to retrieve information on the data, tools and services that the respondents have experience of using.

The questionnaire asked “What technologies do you have experience of (e.g. satellite, measurement instruments, remote sensing, visualisations)?” and respondents were able to answer using free-text. Two-thirds (11) of respondents indicated they had experience of satellite and/or remote sensing data. Other technologies listed by respondents included GIS, landscape analysis, instrumentation, visualisations and data analysis.

For tools and software used on a day to day basis, experience was mainly in GIS applications (12 listed GIS applications of different types), also mentioned were R, Word, Excel, Photoshop and data base processing.

A wide range of data types were listed as being used as part of the day-to-day job, including vector, raster, satellite imagery (Landsat and Sentinel), fisheries, sea surface temperature, sea level pressure, (hydro) meteorological data, landcover, topographical data, human settlement location and extent, land use, bathymetric survey, lidar, Shuttle Radar Topography Mission (STRM) data, tidal data, biological, biophysical, socio-economic and environmental data.

Finally, for this section, we asked “What types of data or information would make your job easier?” Answers included:

- Risk and disaster information
- Data for modelling in mangrove restoration
- Environmental data
- Satellite imagery in time series and at high resolution
- Surface temperature
- Surface currents
- General oceanographic and land data.

3.3 Sea Level Data Requirements and Applications

The first question in this section asked if the respondent used sea level data or information in their work. 10 answered yes, seven said they did not. This was followed with a question asking what applications they needed sea level data for (free text entry with some potential options listed). All respondents provided answers even if they said they did not currently use sea level data, indicating that if sea level data was widely available, they would use it in the future.

The applications that sea level data were used for were slightly biased towards coastal management, planning and conservation (57%), as opposed to research or operational applications (43%). Five respondents needed sea level data for both management and planning applications and scientific research. Answers are listed in detail below (number of responses in parentheses):

- Coastal Management (12)
- Planning (10)
- Conservation (9)
- Scientific Research (8)

- Forecasting (6)
- Port Operations (3)
- Operational Applications (2)
- Coastal Engineering (2)
- Business Applications (2)

Information provided in “further details’ mostly related to management and planning applications. Responses included:

- report on the state of marine and coastal ecosystems,
- marine spatial planning projects,
- sea level change impacts,
- coastal protection measures and impact assessments,
- spatial mapping of fishing effort and target resource.

When asked what sea level data they used, respondents replied with multiple options. Roughly equal numbers listed satellite data (11), as tide gauge data (10), with five indicating they used both. Fewer used model predictions (six), and nine used historical trends.

Respondents were asked what the most important locations in Madagascar were for sea level data, and a large number of coastal locations were listed. Locations were listed at a range of scales, these are listed in table 1 and Regional Areas and Specific Locations are identified on a map in Figure 4.

Table 1. Important locations for sea level data

Scale	**Location**
Large scale	All Coasts; Western parts; shrimp fishing zone; maritime emergency zones; Madagascar Exclusive economic zone
Regional areas	Diana; Northern Diana region; Boeny region; Sava region; Manambolo-Tsiribihina region, North-East (Sainte Marie); North-West (Maintirano) coast; West coast - Maintirano to Mahajanga; Northwest - Radama archipelago to Nosy Hara; East coast - Toamasina to Eastern Cape
Specific locations	Diego Suarez, Toamasina, Mahajanga, Manakara, Toliara, Morondava, Nosy-Be, Sainte-Marie, Manakara, Fort Dauphin, Vangaindrano, Mananar, Cap Est, Antalaha, Sava

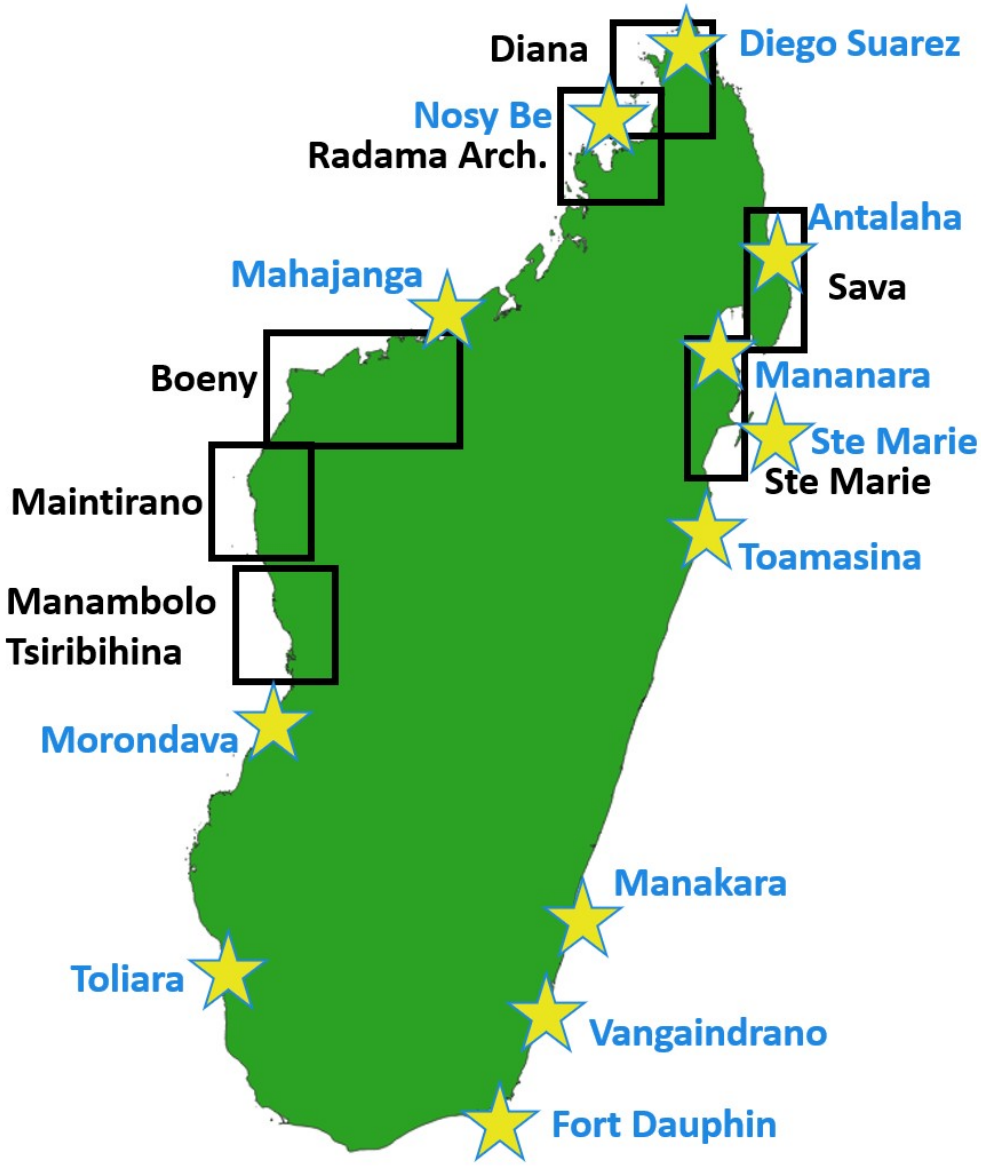

Figure 4. The locations of the regional areas (black boxes) and specific sites (stars) for which sea level data was required

Finally, in this section, a wide variety of sources from which sea level data were accessed were indicated:

- National Sources: Météo Madagascar, tidal calendar
- International Tide Gauge networks: Permanent Service for Mean Sea Level (PSMSL), Réseau d'observation du niveau de la mer (RONIM), Global Sea Level Observing System (GLOSS)
- Other International Sources of coastal data: World imagery, ASTER Global Digital Elevation Map (NASA), World topo Map (ARC GIS base map), Landsat global imagery (NASA), NOAA digital coast, open topography lidar portal (open source topography data, University of California San Diego)
- Applications: Windy

3.4 Priorities, Risks and Challenges

When asked for the priority requirements for sea level data, there was a wide range of responses, including applications and specific parameters or data characteristics. These are listed in table 2, below, grouped according to themes.

Table 2. Priority requirements for sea level data

Applications	Parameters	Characteristics
Risks Disasters Coastal retreat Marine erosion Coastal protection work Livestock and marine culture Hotels Urban planning	Waves and winds Sea level rise Tidal predictions Cyclone surges Tide gauge data Satellite data Sea level at specific times and places	Interoperable Daily data Regularity Timely and high resolution

The responses to the question “What are the main problems or gaps in sea level data for Madagascar?” also covered a wide range, and are grouped into general themes in table 3, below.

Table 3. Gaps in sea level data for Madagascar

Data Issues	Resources	Knowledge and Skills	Other
Sparse data Difficult to access No / limited real time data Data for specific locations	Lack of means and logistics for surveillance Technical and computer hardware	For analysing data	High risk on public investment along the coasts Restrictions on livestock farming and marine culture Hampers the development of tourism and tourism activities

Finally, under data issues, answers to the question “What data or information would make your job easier?” included specific data types, general issues, and certain data characteristics, see table 4, below.

Table 4. Additional data needs

Types	Parameters	Characteristics
Real time data Forecast data Satellite imagery Periodical sea level change Meteorological and oceanographic fluctuations Seasonal variations	Surface currents (High resolution) satellite altimetry Bathymetry Ocean surface and topography	Easy to handle formats

The next set of questions asked about risks and challenges.

The greatest risks to the Madagascar coastline were thought to include both events and impacts:

- Events: Tsunami, rising seas, cyclones, human activities, forest destruction,
- Impacts: Coastal erosion, flooding, destruction of coastal areas, erosion and displacement of villages, lifestyle impacts, food insecurity, seafood availability, habitat loss, hyper sedimentation, submersion, dangers to shipping, collisions, marine pollution, loss of revenue, environmental degradation

Whilst, the best ways of managing Coastal Risk were thought to be infrastructure developments; improved monitoring and data collection; and education and awareness training. See table 5 for more detailed information.

Table 5. Ways to manage coastal risk

Infrastructure and planning
Early warning, updating of current situations and future risk modelling
Real Time data provided to alert centres and used to identify risk areas, predictive models
Implementation of coastal, marine and environmental mitigation and resilience projects
Safety boats to monitor coasts and marine activities.
Natural protection / nature-based solutions (e.g. mangroves, reforestation)
Improved planning: Integrated Coastal Zone management, development measures not at coast
Mapping of risk areas. Coastal erosion modelling
Placement of development activities to areas higher than coastlines

Table 5 cont. Ways to manage coastal risk

Infrastructure and planning

Establishment of protective infrastructure in areas with a considerable rate of retreat of the coastline Reinforcement of coastal protection infrastructure if not displacement of population out of flood-prone areas Reforestation (e.g. reeds and other anti-erosion plant) upstream especially along watercourses; and reforestation of mangroves on the coast
Monitoring and data collection
Establish coastal / oceanic stations, coastal radar. Reliable data on tides. Real time data Make use of traditional knowledge and expertise Improved collection of data and access to (understandable) data, Reliable information in suitable format
Education and awareness training
Education and awareness raising in population Animate alert centres at the local level Integration of awareness-raising actions and local/regional development plans Having reliable data to transform them into messages for the population

The ability of coastal communities in Madagascar to resist or adapt to climate change impacts of sea level rise and changes in storms and cyclones was seen to be low by our respondents. This was due to low incomes and the lack of alternative livelihoods in fishing communities. However, traditional knowledge and expertise on the environment and climate were recognised as an advantage.

The need for targeted support to enable communities to develop adaptation strategies and improve resilience was noted, as well as the requirement to improve infrastructure, integrating risk and disaster models into planning and implementing new construction techniques. The importance of education and awareness raising, and of improved communication was also highlighted by a number of respondents, as was the need for improved early warning systems.

The final question in this section asked for the best ways to manage risk to the coastal and marine environment of Madagascar. Answers included improved data and information, coastal protection, coastal management and raising awareness.

In terms of coastal zone management and planning, recommendations included the implementation of coastal, marine and environmental mitigation and resilience projects, the adoption of nature-based solutions (e.g. reforestation), the zoning of the coastal zone and the establishment (or extension) of natural and artificial barriers. These developments should consider the responsibilities of the relevant existing entities at national and sub-national levels.

The need for improvements in the provision and use of data and information was recorded. This included the need to establish and use reliable data bases and to develop predictive models for risk and set up alert systems was also noted. Access to data for the coastal population should also be improved, which would facilitate their exploitation and also play a part in education and wider awareness raising in the coastal communities.

Finally, it was recommended that a system of safety boats should be established, in order to monitor the coasts and maritime activities.

3.5 Capacity Building and Training

Of the 17 respondents, 16 expressed an interest in receiving training, with only one not interested. Additional aspects of training requested included:

- Coastal, marine and environmental projects
- Coastal management, coastal and maritime planning, coastal defence planning.
- Coastal flooding models with sea rise
- Socio-economic impacts
- Projection and causes of sea level rise for Madagascar
- relationship between wind temperature and sea level
- satellite data for fisheries management
- impact of climate change on marine ecosystems
- strategy to combat flooding and sea level change.

4 C-RISe Project – Workshop Recommendations

It is interesting to compare the questionnaire responses to recommendations that came from a workshop held at the end of the UK Space Agency funded C-RISe project in February 2020 in Antananarivo, Madagascar on the impacts of climate change on Madagascar's coast and marine environment. The workshop recommendations are largely consistent with the questionnaire responses.

There were 45 participants to the workshop from across Madagascar, including representatives from government agencies, NGOs and research institutions.

Priority application areas for workshop participants included marine planning, coastal erosion and protection, impacts on marine ecosystems, tropical cyclone tracks, and impacts of all aspects of climate change on human activities and livelihoods.

Recommendations of priorities for building capacity in the use of marine satellite data and modelling and Madagascar are summarized below:

Availability of data and information products

In addition to those data sets already being supplied through C-RISe (climatologies of wind, wave, surface current and sea level data, and near real time wind, wave and surface current data) a range of high-resolution data sets, time series to monitor change, additional parameters, and derived products (ecosystem threats, maps of coastal change, oceanic fronts) were identified as priority requirements.

Modelling Capability

Development of capacity to use models for a range of applications was identified as a priority. These ranged from high resolution coastal modelling, through ecosystem models, large scale ocean-atmosphere models, flood risk modelling, and oil spill dispersion models and modelling for planning and resource management.

Capacity to access, analyse, combine and share datasets (skills and IT resources)

In addition to filling gaps in data requirements, and modelling capability, there is a need to build capacity to analyse, interpret and combine data from different sources, and to improve systems and policies so that data can be shared between different organisations. There is also a need to build capacity in IT resources, including improving internet connectivity.

Communication of information to non-scientific audiences

Building capacity to extract relevant science-based information and communicate this to non-scientific audiences at different levels is essential for uptake of satellite data among decision makers in government and civil society, and to sensitise coastal communities to the need for healthy coastal and marine ecosystems.

Adaptive Capacity

Throughout the workshop a need for cross organisational working, the sharing of data, information, technical skills were emphasised. Currently, many organisations in Madagascar act independently in the generation, processing and management of coastal data, meaning that much useful data and information are not used effectively.

5 Summary

There were a total of 17 respondents to the questionnaire, representing a wide range of users and applications of sea level data. This has enabled us to form a broad initial overview of what data is currently being used and what the needs are in terms of both data availability and capacity building.

A large proportion of respondents were at management level, and work for government in some capacity. This appears to be reflected in the applications of interest and requirements, which tend to relate to the need for coastal and management.

It has not been possible to draw strong conclusions, in terms of specific detailed requirements for sea level data. This is due to the extreme lack of data which is currently available and the range of areas from which our respondents were drawn (although this may not be representative of all potential users of sea level data in Madagascar). The current lack of sea level data for Madagascar, the result of an absence of long-term tide gauge data, has resulted in limited capacity to use these data and the need for data for a wide range of locations (Figure 4).

These general findings are consistent with the outcomes of a 2-day workshop held in Antananarivo in 2020, which provided recommendations across a range of themes. From this, we should understand that the provision of an improved sea level monitoring capability should be complemented by a wider capacity building effort.

Appendix: PASS-SWIO Questionnaire

PASS-SWIO User Requirements

Page 1: Page 1

PASS-SWIO User Requirements Survey

Dear PASS-SWIO stakeholder

Thank you very much for agreeing to complete this survey. These questions are designed to help the PASS-SWIO project team (DGM, NOC and SatOC) understand the requirements of colleagues in Madagascar for sea level data.

You are free to decide which questions you want to answer, the more information you can provide, the better we can help to plan a sea level monitoring system for Madagascar that meets your needs. The survey should take around 20 minutes. Feel free to answer questions in bullet points or short notes to save time.

Please share this survey link with any of your colleagues who you think can also fill out this survey to get more information from your organisation.

Your responses will be confidential and we will not store identifying information such as your name, email address unless you specifically agree to us doing so. The data are stored confidentially in a password protected format, only senior PASS-SWIO project members have access to the survey information.

Please contact Dr David Cotton, director of SatOC Ltd UK if you have any questions or concerns.
d.cotton@satoc.eu

1. Do you agree to allow your information to be used by the PASS-SWIO project team and consent to your data being stored as described above?

- ○ Agree

1 / 12

- Not Agree

2. We might like to contact you further about your responses. Are you happy for us to do this?

More info

- Agree
- Not Agree

2.a. If you agree please enter your name

2.a.i. and your email address

Page 2: About You

3. What is your age?

- ○ Under 25
- ○ 25-35
- ○ 36-45
- ○ 46-60
- ○ Over 60
- ○ Prefer not to answer

4. What is your gender?

- ○ Female
- ○ Male
- ○ Other
- ○ Prefer not to answer

5. What is your area of expertise / employment

- ☐ Government
- ☐ Meteorology
- ☐ Oceanography
- ☐ Fisheries
- ☐ Conservation
- ☐ Coastal Zone Management
- ☐ Emergency response
- ☐ Mapping
- ☐ Engineering

- [ ] Planning
- [ ] Operations Management
- [ ] Other

5.a. If you selected Other, please specify:

6. What is your education level, training background and expertise? (e.g. Bachelor degree, PhD, meteorology, with expertise in ocean modelling)

7. How many years' experience do you have in your field?

8. Who is your employer?

9. What is your employer organisation's primary industry? (e.g. academia, scientific research, government department, national agency, Non Governmental Organisation, marine safety)

10. What is your job title?

Page 3: Data, Tools and Services

11. What technologies do you have experience of? (e.g. satellite, measurement instruments, remote sensing, visualisations)

12. What tools and software do you use in your day to day job?

13. What types of data or information do you use in your day to day job?

14. What types of additional information or data would make your job easier?

Page 4: Sea level data requirements and applications

15. Do you use sea level data or information in your work?

- ○ yes
- ○ no

16. What application do you need sea level data for?

- ☐ Scientific Research
- ☐ Operational Applications
- ☐ Forecasting
- ☐ Coastal Management
- ☐ Coastal Engineering
- ☐ Planning
- ☐ Conservation
- ☐ Port Operations
- ☐ Other

16.a. If you selected Other, please specify:

16.b. Please add further details

7 / 12

17. What sea level data do you use?

- [ ] Tide gauge data
- [ ] Model predictions
- [ ] Satellite data
- [ ] Historical sea level data (e.g. trends)
- [ ] Other

17.a. If you selected Other, please specify:

18. What are the most important locations in Madagascar that you need sea level data for?

19. Where do you access your sea level data from? Local sources, or online web directories (e,g, PSMSL, GLOSS, CMEMS, PODAAC,...)

Page 5: Priorities, Risks and Challenges

20. What are your priority requirements for sea level data?

21. What are the main problems / gaps in sea level data for Madagascar?

22. What kind of data or information would make your job easier?

23. What do you think are the greatest risks to the coast of Madagascar (include risks to the population and to the environment)?

24. Can you describe your views on the best ways to manage coastal flood risk and erosion issues at the coast in Madagascar?

25. How well do you think the coastal communities in Madagascar can either adapt or resist sea level rise and changes in storms and/or cyclones?

26. Can you describe your views on the best ways to manage risk to the coastal and marine environment in Madagascar?

Page 6: Capacity Building and Training

We plan to deliver training (primarily to DGM staff) in Antananarivo later in the project. This will cover accessing sea level data, processing and quality control of tide gauge data, and carrying out analyses of sea level data from satellite and in-situ data.

27. Would you like to participate in this training

- yes
- no

28. Are there other aspects of sea level science that you would like to receive training for? Please describe them

Page 7: Final page

Thank you very much for your input and time completing this survey. We look forward to speaking with you soon.